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PATENT

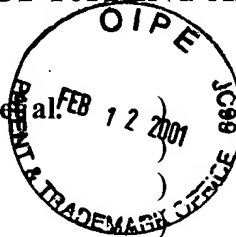
**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES**

Applicant: **Kenichi Nanbu, et al.**

Appln. No.: 09/233,073

Filed: January 19, 1999

For: METHOD OF ETCHING



Examiner: L. Vinh

Group Art Unit: 1765

APPELLANTS' BRIEF ON APPEAL

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Respectfully submitted,

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APPELLANTS' BRIEF ON APPEAL



I. THE REAL PARTY IN INTEREST

The Assignees of this patent application, Kenichi Nanbu (also one of the inventors, 50% interest) and Tokyo Electron Limited (50% interest), are the real parties in interest (Assignment recorded in the U.S. PTO on April 20, 1999 at Reel 009891, beginning at frame 0890). Kenichi Nanbu is a Japanese citizen who resides at 2-347, Takamori 4-chome, Izumi-ku, Sendai-shi, Miyagi-ken, Japan, and Tokyo Electron Limited is a corporation of Japan having a place of business at 3-6, Akasaka 5-chome, Minato-ku, Tokyo-to, Japan.

II. RELATED APPEALS AND INTERFERENCES

To the best of the undersigned's knowledge, no other appeals or interferences will directly affect, will be directly affected by, or will have a bearing on the Board's Decision in this appeal.

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III. STATUS OF THE CLAIMS

Claims 1-14 are pending in this application and constitute the claims on appeal. These claims are reproduced in Appendix A attached to this Brief, as required by 37 C.F.R. § 1.192(c)(9).

IV. STATUS OF AMENDMENTS

Appellants filed an Amendment After Final on July 24, 2000. In an Advisory Action dated August 1, 2000 (Paper No. 12), the Examiner advised that this Amendment would be entered upon filing a Notice of Appeal and an Appeal Brief. Accordingly, Appellants understand that the July 24, 2000, Amendment is entered.

V. SUMMARY OF THE INVENTION

Solid state electronic devices are essential to a vast array of products, processes, and services in use today in the United States and throughout the world. The growing demand for such devices is coupled with increasingly stringent specifications requiring that the devices be produced smaller, faster, and cheaper.

This invention relates to an etching process used in production of semiconductor devices. Generally, in forming semiconductor devices, film forming processes are used for forming various necessary films and layers on semiconductor wafers or glass substrates. These films or layers often are etched to form a desired pattern necessary for various devices, such as semiconductor integrated circuits or LCD panels. See Appellants' specification at page 1, lines 8-12.

When forming, for example, a MOSFET (Metal Oxide Semiconductor Field Effect Transistor), a polysilicon film etching process typically is carried out to form the gate electrode of the transistor. This etching process is very important because the length of the gate electrode of the MOSFET is an important factor in determining the electric characteristics of the device. Therefore, the polysilicon film must be etched over the entire surface of the supporting wafer to form the gate electrode at an accurate length. This gate forming process requires highly accurate and uniform processing. Id. at page 1, lines 13-20.

In many instances, the gate electrode for a MOSFET is produced, by etching, using an inductive coupled plasma processing system that operates at a low pressure.¹ A conventional

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(continued...)

inductively coupled plasma processing system is described and illustrated in conjunction with Fig. 9 of Appellants' application (Id. at page 1, line 28 through page 2, line 22). When a semiconductor wafer film is etched using such a system, however, typically there is a considerable difference between the etch rate at the peripheral part of the wafer and the etch rate at the central part of the wafer, which results in a non-uniform etch. This non-uniformity becomes particularly problematic when etching large wafers (*e.g.*, 12 inch (30 cm) wafers). Id. at page 2, lines 23-31.

Appellants' invention addresses this non-uniformity problem and provides an etching method capable of etching a film at a greatly improved, uniform etch rate. Id. at page 2, lines 34-37. The etching method according to Appellants' invention includes: (a) supplying an etching gas into a plasma producing chamber; (b) producing a plasma in the chamber by applying radio frequency power to the etching gas which thereby produces radicals from the etching gas; and (c) etching an object to be processed in an evacuated reaction chamber, which is connected to the plasma producing chamber, by the radicals flowing from the plasma producing chamber into the reaction chamber. In the claimed process, the etching gas is supplied at a supply rate of 8.4 sccm ("standard cubic centimeters per minute") or above per liter of the reaction chamber. Id. at page 3, lines 9-20. When the etching gas is supplied at the claimed supply rate, uniformity of etching over the surface of the object and the etch rate are improved. Id. at page 3, lines 21-24.

¹(...continued)

Generally, the process pressures used in conventional diode parallel-plate plasma etching systems are excessively high, and such systems are unable to etch the polysilicon film surface with sufficient uniformity. See Appellants' specification at page 1, lines 21-27.

VI. ISSUES

The following issues are presented for consideration in this appeal:

- (A) Did the Examiner commit reversible legal error in rejecting claim 14 under 35 U.S.C. § 103(a) based on the combination of Collins et al., U.S. Patent No. 5,556,501 (hereinafter "Collins") in view of Szwejkowski et al., U.S. Patent No. 5,338,398 (hereinafter, "Szwejkowski")?
- (B) Did the Examiner commit reversible legal error in rejecting claims 1-6 and 11-13 under 35 U.S.C. § 103(a) based on the combination of Collins in view of Szwejkowski?
- (C) Did the Examiner commit reversible legal error in rejecting claims 7 and 8 under 35 U.S.C. § 103(a) based on the combination of Collins in view of Szwejkowski, and further in view of Tomita et al., U.S. Patent No. 5,593,540 (hereinafter "Tomita")?
- (D) Did the Examiner commit reversible legal error in rejecting claims 9 and 10 under 35 U.S.C. § 103(a) based on the combination of Collins in view of Szwejkowski, and further in view of Tomita?

VII. GROUPING OF CLAIMS

Claims 1-14 are pending in this application and constitute the claims on appeal. For consideration on appeal, these claims are grouped as follows:

- (A) Claims 1-6 and 11-13 stand and fall together;

- (B) Claim 14, which depends from claim 7, is believed to be separately patentable from claims 1-6 and 11-13 in this application and does not stand or fall with these claims (separate arguments relating to the patentability of claim 14 are presented in Section VIII(A), *infra*);
- (C) Claims 7 and 8, which depend from claims 1 and 2, respectively, are believed to be separately patentable from claims 1-6 and 11-13 in this application and do not stand or fall with the other claims (separate arguments relating to the patentability of claims 7 and 8 are presented in Section VIII(C), *infra*);
- (D) Claims 7 and 8 stand and fall together;
- (E) Claims 9 and 10, which depend from claims 3 and 4, respectively, are believed to be separately patentable from claims 1-8 and 11-14 in this application and do not stand or fall with the other claims (separate arguments relating to the patentability of claims 9 and 10 are presented in Section VIII(D), *infra*); and
- (F) Claims 9 and 10 stand and fall together.

VIII. ARGUMENT

In the Final Office Action, the Examiner rejected claims 1-6 and 11-14 under 35 U.S.C. § 103(a) as *prima facie* obvious based on Collins in view of Szwejkowski. The Examiner further rejected claims 7-10 under 35 U.S.C. § 103(a) as *prima facie* obvious based on Collins in view of Szwejkowski and Tomita. For the reasons that follow, Appellants respectfully submit that these rejections constitute reversible legal error and request that this Board reverse the final rejection.

A. The Rejection Of Claim 14 Clearly Is Improper

ISSUE (A): Did the Examiner commit reversible legal error in rejecting claim 14 under 35 U.S.C. § 103(a) based on the combination of Collins in view of Szwejkowski?

ANSWER: Yes, for the reasons described below.

Appellants respectfully submit that the rejection of claim 14, on its face, is improper. Claim 14 depends from claim 7. In the Final Rejection, the Examiner rejected claims 1-6 and 11-14 based on the combination of Collins and Szwejkowski. Notably, claim 14's parent claim, claim 7, was not rejected based on the combination of Collins and Szwejkowski.

As admitted by the Examiner in the April 24, 2000, Final Office Action (see page 4, lines 6-9), neither Collins nor Szwejkowski discloses providing a flow diverging position of the etching gas substantially at or inside the outer periphery of the object being etched, as recited in claim 14 via its dependence from claim 7. It is clearly improper to reject claim 14 based only on Collins and Szwejkowski when its parent claim could not be rejected based solely on these references. Because the rejection of claim 14, on its face, is improper, this rejection must be reversed.

On its merits, claim 14 is believed to be patentable for the reasons discussed below with respect to its parent claims, claims 1 and 7.

B. Claim 1 And Its Associated Dependent Claims Are Not Rendered *Prima Facie* Obvious By Collins And Szwejkowski

ISSUE (B): Did the Examiner commit reversible legal error in rejecting claims 1-6 and 11-13 under 35 U.S.C. § 103(a) based on the combination of Collins in view of Szwejkowski?²

ANSWER: Yes, for the reasons described below.

1. General Background Information Relating to this Issue

Appellants' claim 1 recites an etching method that includes: (a) supplying an etching gas from a gas supply system into a plasma producing chamber; (b) producing a plasma in the plasma producing chamber by applying radio frequency power to the etching gas to thereby produce radicals; and (c) etching an object to be processed in an evacuated reaction chamber that is connected to the plasma producing chamber by the radicals flowing from the plasma producing chamber into the reaction chamber. Claim 1 further recites that the etching gas is supplied at an etching gas supply rate of 8.4 sccm or above per liter of the reaction chamber.

In the Final Office Action dated April 24, 2000, the Examiner rejected claims 1-6 and 11-14 as being unpatentable (obvious) over the combination of Collins in view Szwejkowski. In making this rejection, the Examiner admitted that:

Collins differs from the instant claimed invention as per claim 1 by supplying etching gas of Chlorine at a flow rate of 50 cc instead of an etching gas supply rate of 8.4 sccm or above for a substantial volume of one liter of the processing chamber as claimed in the instant invention.

See the April 24, 2000, Office Action at page 3, lines 9-11. Appellants agree with the Examiner's finding that Collins does not disclose the etching gas supply rate range recited in

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Because claims 2-6 and 11-13 stand and fall together with their ultimate parent claim, claim 1, the following arguments focus on the content of claim 1. These patentability arguments, however, apply with equal force to all of the claims that depend from claim 1.

claim 1 of this patent application. In an effort to address this admitted deficiency in the Collins patent, the Examiner relied upon Szwejkowski. According to the Final Office Action:

Szwejkowski discloses a process for the RIE etching a polysilicon film on a silicon wafer in a vacuum etch chamber using Chlorine etching gas at a rate of from about 40 to about 100 sccm into a 3 liter vacuum processing chamber [citing Szwejkowski at column 4, lines 19-22].

See the April 24, 2000, Office Action at page 3, lines 12-14. From these teachings in Szwejkowski, the Examiner alleged that it would have been obvious to one of ordinary skill in the art to use the flow rate for the etching gas in Szwejkowski's "RIE" system (about 13.3 sccm/l) in the process of Collins because:

Szwejkowski states that using the gaseous component and flow rate of his invention will not result in the undesirable formation of particles on the wafer surface and will not condense at room temperature in the lines used to bring the etchant gases to the vacuum etch chamber [citing Szwejkowski at column 5, lines 49-54].

See the Final Office Action, the sentence bridging pages 3-4. Appellants respectfully submit that the Examiner has failed to carry his burden of demonstrating that the claims are *prima facie* obvious.

2. The Examiner Misconstrued the Teachings of Szwejkowski in an Effort to Find "Motivation" for Combining the Flow Rate of Szwejkowski into the System of Collins

As described immediately above, in the Final Office Action, the asserted "motivation" for combining the teachings of Szwejkowski with Collins is given as follows:

Szwejkowski states that using the gaseous component and flow rate of his invention will not result in the undesirable formation of particles on the wafer surface and will not condense at room temperature in the lines used to bring the etchant gases to the vacuum etch chamber [citing Szwejkowski at column 5, lines 49-54].

See the Final Office Action, the sentence bridging pages 3 and 4. This statement in the Final Office Action, however, misstates the teachings of Szwejkowski. The cited portion of Szwejkowski is reproduced below:

Thus, the invention provides an improved tungsten silicide etch process wherein both tungsten silicide and polysilicon may be etched in an etch process having a high selectivity to both photoresist and oxide, using gaseous components of the etch available in high purity form, which will not result in the undesirable formation of particles on the wafer surface and which will not condense at room temperature in the lines used to bring the etchant gases to the vacuum etch chamber.

See Szwejkowski at column 5, lines 46-54. As evident from these teachings in Szwejkowski, the stated avoidance of particle formation and condensation are not positive effects gained from a specified etchant gas flow rate. This cited passage in Szwejkowski does not even mention or hint at etchant gas flow rates. Rather, the cited advantages are a result of using high purity etch gas. This fact becomes even more apparent when one considers Szwejkowski's discussion of the problems encountered using BCl_3 gas in the prior art (see, for example, Szwejkowski at column 1, lines 39-44). Contrary to the Examiner's assertions, nothing in Szwejkowski correlates avoidance of undesirable particle and condensation formation with selection of a specific etchant gas flow rate.

Therefore, at most, Szwejkowski may have induced the skilled artisan to select a high purity etchant gas in the Collins system in an effort to avoid undesirable particle and condensation formation. Nothing in Szwejkowski, however, teaches or remotely suggests that appropriate selection of the etchant gas flow rate can assist in creating these advantages. Accordingly, the Examiner's cited "motivation" for combining the flow rate of Szwejkowski

with Collins misconstrues Szwejkowski's teachings. Thus, there is no motivation, teaching, or suggestion for combining the flow rate of Szwejkowski into the system of Collins.

3. Because the Methods and Systems of Collins and Szwejkowski Are So Different from One Another, a Person of Ordinary Skill in the Art Would Not Have Been Motivated to Combine Their Teachings in the Manner Suggested by the Examiner

Appellants further assert that a person of ordinary skill in the art would not have been motivated to use the flow rate described in Szwejkowski in the system of Collins. This is because the systems of Collins and Szwejkowski operate very differently from one another. The Examiner, relying solely on hindsight and using Appellants' specification and claims as a guide, selectively combined the teachings of these references in an effort to arrive at Appellants' claimed invention. Because a person of ordinary skill in the art would not have been motivated to make this selective combination, there is no *prima facie* case of obviousness against claim 1 and its associated dependent claims. This rejection should be reversed.

Columns 6-7 of Collins provide a general overview of the Collins system. The Collins system is a plasma reactor chamber system 10 for processing a semiconductor wafer 5 which uses an inductive plasma source arrangement, a capacitively coupled bias arrangement, and preferably a magnetic plasma source confinement arrangement. In Collins, the plasma is generated in plasma chamber 16A, located in the dome 17, through use of radio frequency ("RF") energy supplied by antenna 30 wrapped around the dome 17. See Collins, Figs. 1-3.

In Collins, the wafer support structure 32 includes a portion that acts as a cathode 32C. As described at column 4, lines 27-32 in Collins, the wafer cathode support

arrangement is used for effecting control of the cathode sheath voltage and ion energy, independent of the plasma density control effected by the high frequency power.

Accordingly, Collins is directed to a reactor which features an inductively coupled plasma generating system with an independent, additional capacitive control system.

Notably, in the system described in Collins, the wafer support cathode 32C is not used as an electrode for generating the plasma. Quite to the contrary, Collins expressly distinguishes his inductively coupled plasma generating system, wherein the wafer support is independently used for effecting control of the cathode sheath voltage and ion energy, from "conventional arrangements" that use the wafer support as a cathode for generating the plasma. Specifically, Collins states:

This [system] contrasts with conventional RF system arrangements, in which the RF power is applied between two electrodes, typically the wafer support electrode 32C, the upper surface of which supports wafer 5, and a second electrode which is the sidewalls 12, top wall 13 and/or manifold 23 of the reactor chamber.

See Collins at column 8, lines 44-49. Thus, Collins distinguishes his inductively coupled plasma generating system from those that use a wafer support electrode for generating the plasma.

The system described in Szwejkowski is the type of system distinguished by Collins. Specifically, Szwejkowski describes the plasma generating apparatus used in his invention as follows:

The wafer to be etched is conventionally mounted in the vacuum chamber on a cathode support which is connected to the negative terminal of a grounded power supply. During the etch, a plasma is ignited between the cathode and the

grounded walls of the chamber and the grounded showerhead [emphasis supplied].

See Szwejkowski at column 3, lines 36-41. Because Collins expressly distinguished his system from the type described by Szwejkowski, Appellants respectfully submit that a person of ordinary skill in the art would not have been motivated to combine the teachings of Collins and Szwejkowski in the manner suggested by the Examiner. Rather, Collins expressly teaches away from the combination relied upon by the Examiner in the Final Office Action. For this reason, Appellants respectfully submit that Collins and Szwejkowski are not properly combined to reject claim 1 in this application.

The above differences between the systems of Collins and Szwejkowski also translate into practical reasons as to why a person of ordinary skill in the art would not have been motivated to use the etching gas flow rate of Szwejkowski in the system of Collins. Because the plasmas are generated at different locations and in different manners in these two systems, the etchant gas would be exposed to substantially different flow conditions and flow characteristics in these two systems. Nothing in either Collins or Szwejkowski indicates that a higher etchant gas flow rate might be used in the system of Collins.

Also, Appellants advise that different etching gas flow rates traditionally have been used, depending on the type of reactive ion etching system utilized. Conventional inductively coupled plasma processing systems, like those described in Collins and in conjunction with Fig. 9 in Appellants' specification, operate at a low process pressure and rely upon production of a high density plasma cloud and diffusion spread of the radicals in the low pressure environment so that the radicals fall substantially uniformly on the surface of the wafer being

etched. Thus, under this type of a conventional system, an etching gas flow rate of about 125 sccm per 59 liters (or 2.1 sccm/liter) for chlorine previously has been used to achieve the desired diffusion spread and etching results. See, for example, Appellants' specification at page 1, line 28 through page 2, line 31, and particularly, page 2, lines 9-22.

On the other hand, in reactive ion etching systems featuring a wafer support that acts as a cathode for plasma generation, like that described in Szwejkowski, the charged cathode produces an ion pulling effect that attracts ions formed in the etching gas toward the cathode. Thus, higher etching gas flow rates typically are used in such systems to prevent the gas from concentrating at the center of the wafer and producing a non-uniform etch. Again, nothing in either Collins or Szwejkowski teaches or suggests that the higher etching gas flow rate of Szwejkowski should be used in the system of Collins.

Accordingly, the evidence of record demonstrates that the inductively coupled plasma generating system of Collins differs significantly in operation from the system of Szwejkowski, which utilizes the wafer support as the cathode for plasma generation. The Collins-type systems use low etching gas flow rates to allow the etching gas to diffuse over the entire surface of the wafer. The Szwejkowski-type systems use higher etching gas flow rates because the charged wafer support (*i.e.*, the cathode) would otherwise concentrate too much etching gas at the center of the wafer, thereby producing a non-uniform etch. There is no motivation, teaching, or suggestion in Szwejkowski that the relatively high etching gas flow rate in this system might be useful in the much different, diffusion based system of Collins. Only Appellants' specification and claims provide the motivation or suggestion for applying

Szwejkowski's flow rate to the system of Collins. Thus, this rejection improperly relies on hindsight and Appellants' disclosure and therefore fails to set out a *prima facie* case of obviousness.

**4. There Is No Reasonable Expectation That the Flow Rate of
Szwejkowski Could Be Used Successfully in the System of Collins**

To establish *prima facie* obviousness by combining the teachings of two or more references, there must be some reasonable expectation that the combination would function successfully. See *In re Merck & Co., Inc.*, 800 F2d 1091, 231 USPQ 375 (Fed. Cir. 1986), cited in *The Manual of Patent Examining Procedure* ("M.P.E.P.") § 2143.02.

The systems of Collins and Szwejkowski operate quite differently in the manner in which the plasma is generated, the location at which the plasma is generated, and the manner in which the etching gas reaches the wafer surface (*i.e.*, diffusion v. electrical attraction forces). Thus, a person of ordinary skill in the art would not expect that process conditions useful in Szwejkowski's system could automatically be transferred to the much different Collins system. Additionally, nothing in either Collins or Szwejkowski teaches or suggests that the system of Collins could be expected to work successfully with an increased etchant gas flow rate as described by Szwejkowski. Again, only Appellants' specification and claims bridge the gap in the teachings of Collins and Szwejkowski, but the Examiner is not permitted to rely upon hindsight and Appellants' specification and claims to find the motivation for combining references. Thus, *prima facie* obviousness has not been established for this additional reason.

**5. Response to Other Arguments and Issues Raised by the Examiner in
the Final Office Action**

In a "Response to Arguments" section of the Final Office Action, the Examiner provides a reply to arguments previously made by Appellants. Specifically, the Examiner asserts that:

- 1) it is well known in the art to employ inductively coupled plasma etching to RIE etch polysilicon and Szwejkowski discloses a process for RIE etching of tungsten/polysilicon on a semiconductor wafer,
- 2) both Collins and Szwejkowski disclose plasma etching systems of low pressure and high density, and
- 3) both Collins and Szwejkowski disclose the use of electrodes.

See the April 24, 2000, Office Action at page 5. These arguments fail to demonstrate that the Examiner's rejection of claims 1-6 and 11-14 is sound.

The legal standard to be applied by U.S. PTO Examiners for determining whether *prima facie* obviousness has been established is set out in *M.P.E.P.* § 2143.01 as follows:

Obviousness can only be established by combining or modifying the teachings of the prior art to produce the claimed invention where there is some teaching, suggestion or motivation to do so found either in the references themselves or in the knowledge generally available to one of ordinary skill in the art. *In re Fine*, 837 F.2d 1071, 5 USPQ2d 1596 (Fed. Cir. 1988); *In re Jones*, 958 F.2d 347, 21 USPQ2d 1941 (Fed. Cir. 1992).

As further set out in *M.P.E.P.* § 2143.01, "[t]he mere fact that references can be combined or modified does not render the resultant combination obvious unless the prior art also suggests the desirability of the combination. *In re Mills*, 916 F.2d 680, 16 USPQ2d 1430 (Fed. Cir. 1990) [emphasis in original]."

The general presence of some common elements between Collins and Szwejkowski does not itself provide the required suggestion or motivation to alter the flow rate of Collins

with that described in Szwejkowski. This is particularly true when, as here, the references describe quite different systems and methods.

The fact that both Collins and Szwejkowski generally involve reactive ion etching ("RIE") systems (argument "1" above) does not, by itself, indicate to one of ordinary skill in the art that any process condition used by Szwejkowski can be transferred to the system of Collins. As described above, these systems are very different from one another. For example, Szwejkowski ignites a plasma between the support cathode and the grounded walls of the chamber and the grounded showerhead. The plasma location and generation in Szwejkowski is quite different from that of Collins, who generates a plasma in plasma chamber 16A located in a dome 17 surrounded by an antenna 30. Because the plasma location, generation, and maintenance in Collins and Szwejkowski are quite different, a person of ordinary skill in the art would not expect that the etchant gas flow rate of Szwejkowski could be automatically transferred into the system of Collins. Thus, the mere fact that both Collins and Szwejkowski are generally directed to RIE etching techniques does not provide one of ordinary skill in the art with a suggestion or motivation for using Szwejkowski's etchant gas flow rate in the system of Collins.

With reference to argument "2" above, the fact that both references may describe "low pressure and high density" systems does not take away from their significant differences as described above. Also, with respect to argument "3", the fact that each system uses "electrodes" does not provide the necessary motivation or suggestion for changing the etchant gas flow rate in Collins' system with that of Szwejkowski. Notably, the electrodes are used in

the two systems in completely different manners. Specifically, in Szwejkowski, the wafer support electrode is used to support the plasma (Szwejkowski at column 3, lines 36-41), and in Collins, the wafer support electrode is used for supplemental control of the sheath voltage and ion energy independent of the plasma density control (Collins at column 4, lines 27-32).

6. Conclusion Regarding the Obviousness Rejection of Claim 1 and its Associated Dependent Claims

For the reasons described above, Collins and Szwejkowski are not properly combined to reject Appellants' claims 1-6 and 11-14. Because the systems of Collins and Szwejkowski are so different, one of ordinary skill in the art would not have been motivated to select the etchant gas flow rate of Szwejkowski and use it in the system of Collins. Also, because of the significant differences between these systems, there is no reasonable expectation that the system of Collins would operate successfully if such a change were made. Moreover, the Examiner has provided no reason as to why a person of ordinary skill in the art would have been motivated to change the etchant gas flow rate in Collins' system with that used by Szwejkowski.

Accordingly, the Examiner has failed to carry his burden of establishing that Appellants' invention, as defined in claim 1, is *prima facie* obvious. Therefore, the rejection of claims 1-6 and 11-14 should be reversed.

C. Claims 7 and 8 Are Not Rendered *Prima Facie* Obvious By Collins, Szwejkowski, And Tomita

ISSUE (C): Did the Examiner commit reversible legal error in rejecting claims 7 and 8 under 35 U.S.C. § 103(a) based on the combination of Collins in view of Szwejkowski, and further in view of Tomita?

ANSWER: Yes, for the reasons described below.

Claims 7 and 8 ultimately depend from claim 1, and the Examiner's rejection of these claims is believed to be erroneous for the reasons described above with respect to claim 1. These reasons are incorporated herein by reference. Additional arguments with regard to the separate patentability of claims 7 and 8 follow.

In addition to the features of their parent claims, claims 7 and 8 recite that the etchant gas is provided at a flow rate which produces a flow diverging position that is substantially at or internal to an outer periphery of the object being etched. This feature of Appellants' invention is illustrated in Figs. 7A and 7B. As described in the paragraph bridging pages 9 and 10 of Appellants' specification, when the etchant gas supply rate is higher (as recited in Appellants' claims), the diverging position of the flow is located at or inside the object being treated. When the etchant gas flow rate is lower, as shown in Figs. 8A and 8B, the diverging position moves outside the object being treated. Such an outside diverging position produces a strong flow of etching gas toward the central part of the wafer and increases the etch rate at the peripheral part of the wafer. Therefore, increase in the etch rate at the peripheral part of the wafer can be suppressed when the etching gas supply rate is high and the diverging position is moved inward. This improves uniformity of the etch rate over the surface of the object being treated. See Appellants' specification at page 9, line 27 through page 10, line 10.

In the Final Office Action, the Examiner admitted that neither Collins nor Szwejkowski discloses this feature of Appellants' claimed invention. In an effort to address this admitted deficiency, the Examiner relied upon Tomita. Specifically, the Examiner stated:

Tomita discloses a plasma etching method comprises a step of distributing gas flowing speed (flow rate) linearly increases (diverging position) from the center of the wafer to reach the highest speed in the peripheral portion of the wafer [citing Tomita at column 7, lines 21-24].

See the April 24, 2000 Final Office Action at page 4, lines 10-12.

Tomita relates to a parallel plate electrode plasma generator system with various hole dimensions in its etching gas shower head to influence the downstream distribution of gas flow from the shower head. At column 7, Tomita discusses Figs. 13 and 14. Specifically, this portion of Tomita states:

FIGS. 13 and 14 indicate that the distribution of the gas flowing speeds right above the wafer is not dependent on the diameter *d* of the small hole made in the shower electrode. It is also shown that the gas flowing speed is linearly increased from the center of the wafer to reach the highest speed in the peripheral portion of the wafer.

See Tomita at column 7, lines 19-24. This portion of Tomita states that the gas flow speed increases as one gets further from the center of the wafer, reaching its highest speed at the peripheral portion of the wafer. This portion of Tomita, however, does not state that the flow rate is selected such that the flow of etchant gas produces a flow diverging position (*i.e.*, a location where the flow pattern diverges) substantially at or internal to the outer periphery of the object being etched, as recited in Appellants' claims 7 and 8. Flow speed and the location where a flow pattern diverges (the "flow diverging position") are simply two different things.

Because nothing in Tomita discloses or suggests that the flow diverging position is located substantially at or internal to the outer periphery of the object being etched, as recited in Appellants' claims 7 and 8, and nothing in the other cited references discloses or suggests this feature of Appellants' claims, claims 7 and 8 are not rendered *prima facie* obvious by the

combination of Collins, Szwejkowski, and Tomita. Reversal of this rejection is earnestly solicited.

D. Claims 9 and 10 Are Not Rendered *Prima Facie* Obvious By Collins, Szwejkowski, And Tomita

ISSUE (D): Did the Examiner commit reversible legal error in rejecting claims 9 and 10 under 35 U.S.C. § 103(a) based on the combination of Collins in view of Szwejkowski, and further in view of Tomita?

ANSWER: Yes, for the reasons described below.

Claims 9 and 10 ultimately depend from claim 1, and the Examiner's rejection of these claims is believed to be erroneous for the reasons described above with respect to claim 1. These reasons are incorporated herein by reference. Additional arguments regarding the separate patentability of claims 9 and 10 follow.

In addition to the features of their parent claims, claims 9 and 10 recite that the etchant gas is provided at a flow rate which produces a flow diverging position that is internal to an outer periphery of the object being etched. This feature of Appellants' invention is best illustrated in Fig. 7A. As described in the paragraph bridging pages 9 and 10 of Appellants' specification, when the etchant gas supply rate is higher (as recited in Appellants' claims), the diverging position of the flow is located at or inside the object being treated. When the etchant gas flow rate is lower, as shown in Figs. 8A and 8B, the diverging position moves outside the object being treated. Such an outside diverging position produces a strong flow of etching gas toward the central part of the wafer and increases the etch rate at the peripheral part of the wafer. Therefore, increase in the etch rate at the peripheral part of the wafer can be suppressed

when the etching gas supply rate is high and the flow diverging position is moved inward. This improves uniformity of the etch rate over the surface of the object being treated. See Appellants' specification at page 9, line 27 through page 10, line 10.

In the Final Office Action, the Examiner admitted that neither Collins nor Szwejkowski discloses this feature of Appellants' claimed invention. In an effort to address this admitted deficiency, the Examiner relied upon Tomita. Specifically, the Examiner stated:

Tomita discloses a plasma etching method comprises a step of distributing gas flowing speed (flow rate) linearly increases (diverging position) from the center of the wafer to reach the highest speed in the peripheral portion of the wafer [citing Tomita at column 7, lines 21-24].

See the April 24, 2000 Final Office Action at page 4, lines 10-12.

Tomita relates to a parallel plate electrode plasma generator system with various hole dimensions in its etching gas shower head to influence the downstream distribution of gas flow from the shower head. At column 7, Tomita discusses Figs. 13 and 14. Specifically, this portion of Tomita states:

FIGS. 13 and 14 indicate that the distribution of the gas flowing speeds right above the wafer is not dependent on the diameter d of the small hole made in the shower electrode. It is also shown that the gas flowing speed is linearly increased from the center of the wafer to reach the highest speed in the peripheral portion of the wafer.

See Tomita at column 7, lines 19-24. This portion of Tomita states that the gas flow speed increases as one gets further from the center of the wafer, reaching its highest speed at the peripheral portion of the wafer. This portion of Tomita, however, does not state that the flow rate is selected such that the flow of etchant gas produces a flow diverging position (*i.e.*, a location where the flow pattern diverges) internal to the outer periphery of the object being

etched, as recited in Appellants' claims 9 and 10. Flow speed and the location where the flow pattern diverges (the "flow diverging position") are simply two different things.

Because nothing in Tomita discloses or suggests that the flow diverging position is located internal to the outer periphery of the object being etched, as recited in Appellants' claims 9 and 10, and nothing in the other cited references discloses or suggests this feature of Appellants' claims, claims 9 and 10 are not rendered *prima facie* obvious by the combination of Collins, Szwejkowski, and Tomita. Reversal of this rejection is earnestly solicited.


IX. CONCLUSION

As described above, the references relied upon in the Final Office Action are not properly combinable to reject claims 1-14 in this application. The Examiner has not carried his burden of proving that these claims are unpatentable, and therefore, the final rejection of claims 1-14 in this application constitutes reversible error. Reversal of this final rejection is earnestly solicited.

Respectfully submitted,

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Attorney Docket No. 033082R003

X. APPENDIX A

Pursuant to 37 C.F.R. § 1.192(c)(9), this Appendix contains a clean copy of claims 1-14, the claims involved in this appeal.

1. (Original) An etching method comprising:

an etching gas supply step of supplying an etching gas through a gas supply system into a plasma producing chamber;

a plasma producing step of producing radicals in the plasma producing chamber by converting the etching gas into a plasma by applying radio frequency power to the etching gas; and

an etching step of etching an object to be processed in a reaction chamber, which is connected to the plasma producing chamber and is evacuated, by the radicals flowing from the plasma producing chamber into the reaction chamber;

wherein the etching gas is supplied through the gas supply system at an etching gas supply rate of 8.4 sccm or above for a substantial volume of one liter of the reaction chamber.

2. (Original) The etching method according to claim 1, wherein the plasma producing step converts the etching gas into a plasma by inductive coupling using an induction coil.

3. (Original) The etching method according to claim 1, wherein the etching step uses chlorine gas as the etching gas and etches a polysilicon film formed on the object to be processed.

4. (Original) The etching method according to claim 1, wherein the etching gas supply rate is 8.4 sccm to 16.9 sccm for a substantial volume of one liter of the reaction chamber.

5. (Original) The etching method according to claim 2, wherein the etching gas supply rate is 8.4 sccm to 16.9 sccm for a substantial volume of one liter of the reaction chamber.

6. (Original) The etching method according to claim 3, wherein the etching gas supply rate is 8.4 sccm to 16.9 sccm for a substantial volume of one liter of the reaction chamber.

7. (Amended) The etching method according to claim 1, wherein a flow of etchant is provided at a flow rate which produces a flow diverging position with respect to an outer periphery of an object being etched that is substantially at or internal to the outer periphery of the object being etched.

8. (Amended) The etching method according to claim 2, wherein a flow of etchant is provided at a flow rate which produces a flow diverging position with respect to an outer periphery of an object being etched that is substantially at or internal to the outer periphery of the object being etched.

9. (Amended) The etching method according to claim 3, wherein a flow of etchant is provided at a flow rate which produces a flow diverging position that is internal to an outer periphery of an object being etched.

10. (Amended) The etching method according to claim 4, wherein a flow of etchant is provided at a flow rate which produces a flow diverging position that is internal to an outer periphery of an object being etched.

11. (Original) The etching method according to claim 1 wherein the process pressure is about 5 to about 10 mTorr.

12. (Original) The etching method according to claim 11 wherein the process pressure is 5 mTorr.

13. (Original) The etching method according to claim 4 wherein the process pressure is about 5 to about 10 mTorr.

14. (Original) The etching method according to claim 7 wherein the process pressure is about 5 to about 10 mTorr.